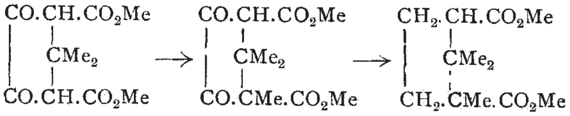
tribromide to unsaturated compounds containing the group —CH : CH—. Thus desoxybenzoin, $C_6H_5.CH_2.CO.C_6H_5$, is reduced to stilbene, $C_6H_5.CH : CH.C_6H_5$, and diphenylpyrazolone to diphenylpyrazole. The method is also applicable to some compounds containing the group —NH.CO—, and carbostyril is in part reduced by phosphorus tribromide to quinoline.

THE long sought synthesis of camphoric acid has been recently accomplished by Dr. Komppa, of Helsingfors (Finland), and is described in the *Berichte* of December 29, 1903. Two years ago the author described the synthesis of apocamphoric acid, which differs from camphoric acid only in the presence of a hydrogen atom in place of one of the methyl groups. The methyl group cannot be introduced directly into apocamphoric acid, but the diketo-apocamphoric ester can be methylated and yields a diketocamphoric acid which can be indirectly reduced to camphoric acid,



$$\begin{array}{l}\mathrm{CO.CH.CO_2Me}\\ \quad|\\ \quad\mathrm{CMe_2}\\ \quad|\\ \mathrm{CO.CH.CO_2Me}\end{array} \longrightarrow \begin{array}{l}\mathrm{CO.CH.CO_2Me}\\ \quad|\\ \quad\mathrm{CMe_2}\\ \quad|\\ \mathrm{CO.CMe.CO_2Me}\end{array} \longrightarrow \begin{array}{l}\mathrm{CH_2.CH.CO_2Me}\\ \quad|\\ \quad\mathrm{CMe_2}\\ \quad|\\ \mathrm{CH_2.CMe.CO_2Me}\end{array}$$

The synthetical acid is optically inactive, but proved to be identical with the known racemic form of camphoric acid. The synthesis includes also the preparation of camphor from its elements, since the conversion of camphoric acid into camphor was accomplished some years ago by Haller. Although the correctness of Bredt's formula for camphor has been fully established by the synthesis of several of its oxidation products, the synthesis of the ketone itself has for some years been one of the most attractive problems in organic chemistry, and its solution completes a not unimportant chapter in the history of chemical progress.

THE additions to the Zoological Society's Gardens during the past week include a Raven (*Corvus corax*), British, presented by Mr. George Ogilvie; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, two Sulphury Tyrants (*Pitangus sulphuratus*) from South America, deposited; a Llama (*Lama peruana*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DISTRIBUTION OF THE STARS.—No. 5, vol. xlviii., of the Harvard College Observatory *Annals* contains a discussion of the distribution of the stars throughout the whole sky. A special point of the discussion was to determine the relative numbers of the stars situated in the Milky Way and those outside its limits. The number of stars in the galaxy was determined from the charts given in Heis's atlas and the Uranometria Argentina; those without were determined from the Harvard Durchmusterungs. Twenty-three tables included in the paper set out the various results in detail, but the following are among the chief facts determined.

The number of stars in a given area of the Milky Way is about twice as great as in an equal area of any other region, and this ratio does not increase for faint stars down to the twelfth magnitude; the proportion of stars of any given magnitude is the same in the Milky Way as in the other regions. The Milky Way covers about one-third of the sky, and contains about half of the stars. There is no evidence of any limit to the faintness of the stars, although the proportionate increase becomes less for each successive magnitude. There are about 10,000 stars of magnitude 6·6 or brighter, 100,000 of magnitude 8·7, 1,000,000 of magnitude 11·0, and 2,000,000 of magnitude 11·9. Although uncertain, it is suggested that there are about eighteen millions of stars visible in a telescope of 15 inches aperture, *i.e.* down to about the fifteenth magnitude.

The distribution of various spectral types has also been considered, and the most striking fact is the preponderance of stars of class "A" and "K" (Harvard), which in a general classification may be taken as typical spectra, the others being simply modifications of these. Many other extremely interesting facts have been elicited during the discussion, but they are too numerous to mention here.

REPORT OF THE WINDSOR, N.S.W., OBSERVATORY.—Mr. Tebbutt's report of the work performed at this observatory (Windsor, N.S.W.) during 1902 deals chiefly with meridian observations for the determination of local time and star places. Most of the extra-meridian work mentioned has already been published in the *Astronomische Nachrichten*, and includes observations of minor planets (for positions) and Perrine's comet (1902 *b*). The reduced measures of fifty-four of the double-stars given in Inne's "Reference Catalogue," involving 1757 settings for position angle and 1503 for distance, have been communicated to the Royal Astronomical Society. The local meteorological results, given in the report, include monthly returns of temperature and rainfall observations, and show that the number of inches, recorded by a rain-gauge placed about 7 feet above the ground, is less than for any year since 1863, being, in fact, about 14·5 inches below the average for forty years. A number of comparisons of the temperatures recorded by two thermometers, one in a Greenwich the other in a Stevenson screen, showed that an excess amounting to between one and two degrees was registered by the former.

A FRENCH-CHINESE CALENDAR.—The "Calendrier Annuaire" for 1904, compiled at the Li-Ka-Wei Observatory, and published at the price of one dollar by the Catholic Mission at Shanghai, is an interesting calendar containing many astronomical, meteorological and physical tables.

The calendar is printed in French, but all proper names and technical terms are also given in Chinese characters and words. Among the more important matters dealt with there occur a lucid explanation of the Chinese calendar, many astronomical tables and explanatory notes, tables for the conversion of Chinese and Japanese standards into European equivalents, facts regarding the population, area and political relations of China, and a number of tables and curves relating to the meteorology of the Chinese Empire.

A BRIGHT BOLIDE.—A remarkable bolide was observed by Mr. W. E. Rolston at Fulham at about 8h. 27m. p.m. on January 9. It appeared at a point situated at about $\alpha = 102°$, $\delta = +18°$, and slowly travelled towards the constellation Cancer, leaving a bright, scintillating, reddish trail. When near to the point $\alpha = 112°$, $\delta = +18°$ (approx.) the head slowly swelled out into a bulbous shape having a yellowish-red hue, became considerably brighter than Jupiter, and then suddenly disappeared. The duration of the complete phenomenon was about five or six seconds.

THE PHYSICAL LABORATORY AT LEYDEN.

AN account of this laboratory, published in NATURE of August 13, 1896 (vol. liv. p. 345), dealt with the inception of the cryogenic department in 1883, and traced its development up to date. It is the purpose of this note to continue the account to the present time, both as regards the more important changes and improvements in the cryogenic department itself, and also in the remaining divisions of the laboratory.

As before, the communications continue to give an almost complete account of the results of the practical work carried out, together with certain more theoretical papers in direct connection with this. Since 1898, the Royal Academy of Amsterdam has published its *Proceedings* in English as well as in Dutch, so that the communications are now corrected reprints of the *Proceedings*. Some idea may be gathered of the increasing output of work when it is noted that in 1896 the current number of the communications was twenty-three, while it has now risen to eighty-eight.

This increasing productivity is mainly due to the much improved appliances, both for manipulation and measurement, which have been developed during the last ten years. Although the original system of three main cycles containing methyl chloride, ethylene and oxygen has been retained, almost every part has been improved and enlarged, so that the ease and rapidity of working are much enhanced. In addition several auxiliary circulations have been constructed in order to add new ranges of temperature to those already obtainable by the main cycles, or at least to make certain temperatures more practicable. Of these the principal are:—(1) a circulation of strong calcium chloride solution cooled to about −23° C. by methyl chloride, and then heated again to the required constant temperature in a thermostat; (2) a nitrous oxide circulation, also in connection with the methyl chloride, for temperatures about −90° C.; (3) air; (4) nitrogen; and (5) methane in connection with the oxygen cycle. In this way the entire range between +5° and −210° can be covered with but few gaps.

The efficiency of the circulations is now very high, as each step in the cascade only lasts about 20 minutes, so that liquid nitrogen even, which requires four operations, is obtained in 1 hour 20 minutes. For this purpose about 6 kg. methyl chloride, 1·3 kg. ethylene, 2·5 kg. oxygen, and 1·0 kg. nitrogen are required, with the pumps running at about 5, 6, 30, and 6 atmospheres pressure in the respective cycles. In order to obtain this speed of work a new large Burckhardt-Weiss pump, with a capacity of 100 litres per second and capable of evacuating to 2 mm. of mercury, has been introduced before the vacuum cylinder of the Pictet conjugated pump in both methyl chloride and ethylene circulations. In the case when a bath of liquid nitrogen is required, one of the two Brotherhood compressors is put into the oxygen circulation, while the nitrogen is compressed in the modified Cailletet pump mentioned before, after passing through an auxiliary pump, to bring it to about 10 atmospheres pressure.

Two methods are employed for conveying the liquid gas required from the cryogenic room to one of three experimenting rooms. Where many measurements at a reduced temperature are desired, hence necessitating a frequent addition of liquid, methyl chloride, nitrous oxide, and ethylene have been conveyed in a copper tube well wrapped up in wool and paper for a distance of about 10 metres. In other cases the liquid is run into specially mounted vacuum glasses, which are transported to the experimental vessel, into which the liquid is siphoned over. Measurements have been made in this way with all the gases mentioned, in vessels which require the use of litres of liquid.

One of Prof. Onnes's chief objects in founding his cryogenic department was the experimental determination of accurate isothermals of pure elementary gases and their binary mixtures, at temperatures near the critical. Although measurements had been made on methyl chloride, carbon dioxide, and mixtures of these with oxygen or hydrogen, no measurements on the latter gases alone had been attempted until about four years ago. The first necessity was a standard open mercury manometer for the very accurate determination of pressures up to 64 atmospheres. Since this has been available, measurements have been made on hydrogen, oxygen, and nitrogen at ordinary and at low temperatures to an accuracy unattained before in such work. At the same time very careful comparisons have been made between the expansion coefficients, at constant volume, of the same gases at low temperatures. In order that these measurements should be possible, it was also necessary to develop the system for the determination of temperature to the accuracy required. For this purpose use has been made of constant volume hydrogen thermometers and of specially prepared and calibrated platinum resistances or thermoelements.

For the most recent measurements it has been found advisable to employ, at the same time, both a temperature indicator and a temperature measurer. The measuring instrument must be sensitive enough for the accuracy required, but the indicator must be set to a higher order. A combination of a platinum resistance, wound upon glass and surrounding the experimental tube, with a thermoelement has usually been employed.

The temperature of an evaporating liquid varies both from the want of homogeneity of the substance and of constancy in the pressure. By suitable adjustment of the pressure, it is possible to make these variations compensate one another, with the result that a nearly constant temperature is obtained. In the thermoelectric circuit variations of 0·01 degree can be immediately seen and corrected by a suitable small change of pressure. Variations due to the pumping machinery and other similar causes are corrected at once from the indications of an oil manometer. In addition, continual stirring by a small motor allows temperatures down to −210° C. to be obtained, which remain constant and uniform to 0·01 degree for an hour in baths 15 cm. in depth.

Preparations are now being made, by the addition of new pumps and other apparatus, for the installation, on the same principles, of a hydrogen cryostate, which will allow of the extension of the range of constant temperatures to the boiling point of hydrogen under reduced pressure.

Since only minor technical difficulties are to be expected, it is probable that this cycle will be completed in a few years' time.

During the past decade several other important investigations have been made. Of these the best known is certainly the discovery and measurement by Dr. Zeeman of the effect which goes by his name. This was largely due to a set of careful experiments and measurements on kindred optical questions, and was tried several times without success. Immediately it was noticed Prof. Lorentz was able to supply the elementary theory, which has subsequently only been elaborated. The discovery thus belongs peculiarly to Leyden, while the partnership was fittingly acknowledged by the joint award of the Nobel prize in 1902.

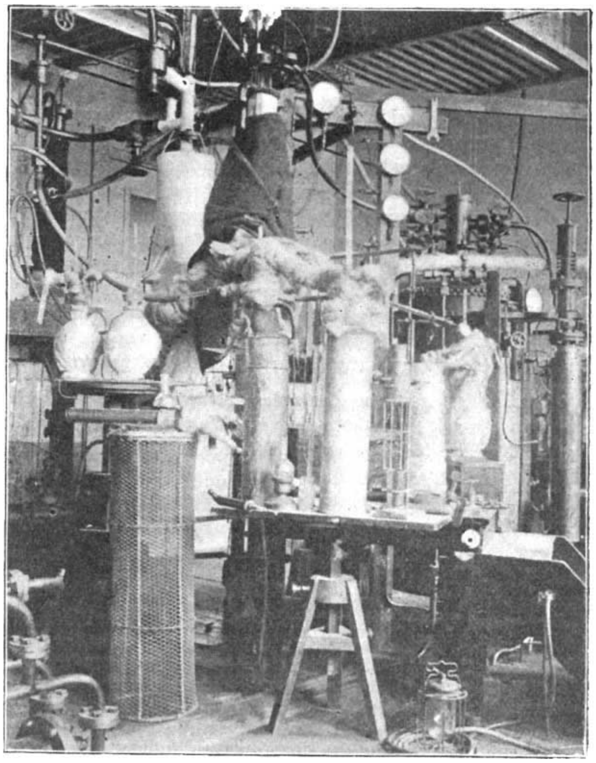


FIG. 1.—The immediate apparatus for the preparation of liquid nitrogen or methane. The liquefied gas is being collected in the metal cylinders in middle of picture. This apparatus stands at the end of the room from which the view shown in 1896 was taken.

What Prof. Onnes considers as to some extent a new method of thermodynamical research has been recently developed by him. It consists in making large accurate models of both the Gibbs (ϵ, η, v) and van der Waals (ψ, v, x) surfaces. By means of these many problems can be treated with comparative ease, which otherwise would either be impossible or would involve very lengthy calculations.

The following list of the principal researches from the beginning of the communications will show clearly the range of work covered.

To make it a continuation of that in the former note the same numbers have been retained:—

(1) Cryogenic department. Pumps, cycles, experimental apparatus, &c. (Nos. 14, 23, 51, 54, 85).

(2) Investigations regarding condensation of mixtures (Kuenen, Nos. 4, 7, 8, 11, 13, 16, 17; Hartman, Nos. 43, 56, 64, Supplement 3; Verschaffelt, Nos. 45, 47, 55, 65; Keesom, 88).

(3) Measurements on capillarity (de Vries, No. 6; Verschaffelt, Nos. 18, 28, 32; van Eldik, No. 39).

(4) Measurements on viscosity of methyl chloride (Stoel and Haas, Nos. 2, 12).

(5) Experiments on Kerr's magneto-optical phenomenon (Sissingh, Wind and Zeeman, Nos. 1, 3, 5, 8, 9, 10, 15, 20); on the influence of magnetism on light (Zeeman, Nos. 29, 33, 36).

(6) Measurements of the Hall phenomenon in bismuth (Lebret, Nos. 15, 19; van Everdingen, Supplement 2, 61, 63, 72).

(7) On Hertz waves in water and electrolytes (Zeeman, Nos. 21, 22, and with Cohn, No. 30).

(8) The dispersion of the magnetic rotation in gases and liquid gases (Siertsema, Supplement 1, Nos. 62, 73, 76, 80, 82).

(9) The accurate measurement of very low temperatures (Kamerlingh Onnes, Nos. 27, 44, 50, and Boudin, No. 60, and Heuse, No. 87; Meilink, No. 77).

(10) Dielectric constants of liquid gases (Hasenoehrl, No. 52).

(11) Accurate isothermals and critical constants of diatomic gases (Schalkwyk, Nos. 67, 70; Kamerlingh Onnes and Hyndman, Nos. 69, 78, 84).

(12) Contributions to the knowledge of van der Waals's ψ surface (Kamerlingh Onnes, Nos. 59*a*, 66, and Reinganum, No. 59*b*, and Happel, No. 86; Keesom, Nos. 75, 79; Verschaffelt, No. 81).

(13) The expression of equations of state by means of series (Kamerlingh Onnes, Nos. 72, 74).

In addition, measurements have been made at low temperatures, and will be published shortly, relating to the pressure coefficient of oxygen and nitrogen at both ordinary and high pressures, and also to the critical phenomena and constants of oxygen.

At the present time the electrical installations of the laboratory are being largely increased. There are already three dynamos which can give a current of 200 amperes at 120 volts, and two motors will be ready shortly to drive some of the pumps and other apparatus.

The possibility of making and fitting the highly specialised and intricate apparatus required for some of these measurements is largely aided by the circumstance that the laboratory is combined with a technical school for instrument making and certain branches of electrical technology. About twenty apprentices are at present passing through the wood, metal, and glass workshops, each of which is controlled by a skilled workman. In this way the construction and repair of apparatus, and the help required for complicated experiments, can be obtained in a most satisfactory manner. This unique combination of research laboratory and technical school is well worth a visit from physicists touring in Holland, who will receive a friendly welcome from Prof. Onnes. H. H. F. HYNDMAN.

AUSTRIAN GEOLOGICAL SURVEY.

SOME important publications of the Austrian Geological Survey have reached us, namely, the first part of the twentieth volume of the *Abhandlungen der k.k. Geologischen Reichsanstalt*, Vienna (1903), the second, third and fourth parts of the fifty-second volume and the first part of the fifty-third volume of the *Jahrbuch* (1902–1903).

The first of these works is a valuable memoir by Ernst Kittl, on the Cephalopoda of the Upper Werfen beds of Muć, in Dalmatia, and other localities, and comprises seventy-seven pages and eleven plates. As indicated by the title, the greater part of the material described in this memoir was obtained from the locality discovered in 1862 at Muć (or Much), in northern Dalmatia, but some of the specimens are from other areas, including certain Alpine localities. Some account is given of the various places where similar strata have been met with, and numerous references are made to the writings of other workers. The description of the various genera and species constitutes the bulk of the work. All the forms noticed are included in two families:—(1) the Ceratitidæ, with the genera Dinarites, Stacheites, Ceratites, and Tirolites; and (2) the family Pinacoceratidæ, with the genera Kymatites, Meekoceras, and Dalmatites. Of these genera Stacheites alone is new to science, but certain subgenera and thirty-four species are described and named for the first time.

In conclusion, the author directs special attention to the importance of the few precursors of the Muschelkalk Cephalopoda, such as Dalmatites, Ceratites, and some nearly allied forms, which are now for the first time known to occur in the Werfen beds.

A comparison with the Permian and Carboniferous fauna of Silesia, Russia, and India shows the comparative poverty of the Werfen beds, and the author points out that the scanty fauna goes "hand in hand" with the small amount of calcareous matter in the deposit.

The second part of the *Jahrbuch* indicated above contains several interesting papers on various subjects, each being illustrated by plates or text figures. Dr. Karl Hinterlechner describes the petrographical characters of some rocks from the Cambrians of western Bohemia. The "Erzberg" in Hüttenberg, Carinthia, is described by Bruno Baumgärtel; Dr. Rudolf Zuber gives us some new studies in the Carpathians; while Hermann Bock supplies an account of the physical structure of the neighbourhood of Brünn. Then follow three palæontological papers:—Rich. Joh. Schubert, on some bivalves from the Istro-Dalmatian "Rudistenkalkes"; Vincenz Hilber, on some fossils from the Gosau beds of Kainach and Söding, in the northern parts of Voitsberg—in this paper one new species is described under the name of *Hippurites Styriacus*; Adalbert Liebus and Rich. Joh. Schubert describe the Foraminifera from the Carpathian Inoceramus beds of Gbellan, in Hungary, seven new species and four new varieties being named. The concluding paper, and certainly not the least important, is by Dr. H. Graf Keyserling, and is entitled "Geologico-petrographical Studies in the Region of the Melaphyre and Augiteporphyry of the Southern Tyrol." This is a detailed communication of some forty pages, which will doubtless be carefully studied by all interested in this particular subject.

The third part is devoted to a detailed account of the localities and horizons yielding useful minerals in the so-called Archaic and Devonian island of Westmähren, by Franz Kretschmer, mining engineer at Steinberg. This memoir of 142 pages deals very fully with the geological and physical conditions under which the graphite, lead, iron ores, &c., are found, and it is illustrated by a geologically coloured map, with sections and plans.

The fourth part of this volume is a memoir by A. Bettner on the Brachiopoda and Lamellibranchiata from the Trias of Bosnia, Dalmatia, and Venetia, occupying 149 pages, and illustrated by ten lithographic plates and seventeen zincographs in the text. The greater part of this work deals with fossils of Middle Trias or Muschelkalk age, derived from several localities, but perhaps a greater interest will be attached to the last twenty pages, dealing with the Upper Trias or Keuper forms from two localities in Bosnia. The whole memoir is a detailed description of species, and, as might be expected from their age and the little known localities from which they are derived, many of them prove to be new, but one cannot but be surprised to find that of some two hundred forms here described one hundred require new names. The plates accompanying this work are clearly drawn, but it is to be regretted that the figures are so crowded. All who have worked with such plates know how troublesome this is; one's eyes become dazed when trying to concentrate upon any particular figure. No doubt this memoir, like the one above noticed on the Werfen Cephalopoda, will become a classic in Triassic literature.

Part i. of vol. liii. contains several papers; the first of these, by R. Hoernes, on the ontogeny and phylogeny of